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HYGIENIC ASSESSMENT OF MUTTON INTENDED FOR EXPORT FROM ELKADARO EXPORT SLAUGHTER HOUSE

By

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Dissertation submitted to the University of Khartoum in partial fulfillment of the requirements of Master degree of Tropical Animal Health (MTAH)

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يَٰٓأَيُّهَا ٱلَّذِينَ ءَامَنُواْ كُلُواْ مِن طَيِّبَٰتِ مَا رَزَقۡنَٰكُمۡ
وَٱشۡكُرُواْ لِلَّهِ إِن كُنتُمۡ إِيَّاهُ تَعۡبُدُونَ ١٧٢

سورةُ البقَرة

dedication

TO:

- **The souls of my parents.**

- **To my elder brother Salaheldin, his sons and daughter.**

- **To my brothers Tarig, Abdelazeem and Ammar.**

- **To my sisters.**

- **To my wife Hajir, my kids Shaimaa, Rumaisaa, Khansaa and Elzuhraa.**

I DEDICATE THIS HUMBLE WORK WITH GENUINE LOVE AND RESPECT.

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ABSTRACT

This study is a trial to evaluate the hygienic quality of mutton intended for export at Elkadaro slaughter house on basis of surface bacterial contamination. The implementation of good hygienic meat control practice in production in Elkadaro slaughter-house were assessed i.e. ante-mortem and post mortem . Seventy five samples were used, these sample were collected in five visits, every visit comprises fifteen samples, five samples were collected from the slaughter hall, the slaughter house chiller and the refrigerated vehicle in the airport after unloaded.

A metallic triangle was used as a template from which swabs were taken; bacterial counts were made, the results of the bacterial count revealed higher counts but no critical contamination levels were recorded.

Total viable cell counts results in this study ranges between 1×10^{3} , 6×10^{6} colony forming units /cm2.

The salient features of the ante-mortem record were that: the average number of the animals entering the slaughter house was 417, while the average number of the accepted animals was 406, average number of rejected animals was 3. the major causes for rejection in the ante-mortem were lameness, tick infestation swelling of the lymph nodes , sheep pox and emaciation. Most of the popular breeds of sheep in the Sudan were brought to the slaughter house (Hamari, Kabashi, Butana).

In the post mortem the average number of carcases accepted was 402. The average number of un accepted carcases was 4.

The causes of un acceptance were Jaundice, hydatidoses, bruises, lymph nodes infection, haematomas and abscessations. The hygiene condition was good and average temperature in the slaughter hall was 34°C.

The chiller showed good hygiene. Average temperature was -0.9, and the average chilling time was 13 hours.

The average holding time in the refrigerated vehicle was 5 hours mean while the average carcase temperature was 0.02 °C . The hygiene in the vehicle was good since neither rancidity nor dripping was observed.

ملخص الأطروحة

هذه الدراسة محاولة لتقييم لحوم الضأن المعدة للتصدير بمسلخ الكدرو وكذلك مسلخ التصدير علي أساس التلوث البكتيري السطحي للذبائح. تم تقييم المعايير الصحية المستخدمة في وقاية إنتاج اللحوم بالنسبة للكشف الحي وفحص ما بعد الذبيح بمسلخ الكدروحيث جمعت خمسة وسبعون عينة في خمسة زيارات، تحتوي كل زيارة علي خمسة عشر عينه حيث تم جمع خمسه عينات من كل من صالة الذبيح بالمسلخ، وغرفة التبريد بالمسلخ، وصالة مطار الخرطوم. تم استخدام مثاث معدني كإطار لأخذ العينات بالمسحة. كما تم عمل حساب للخلايا البكترية النشطة بكل عينه أفضي هذا الحساب إلي وجود أعداد بكتيرية عالية لكنها لم ترق إلي مستوي التلوث. وكانت النتائج بين 1× 10^3 - 6×10^6 خلية مكونة للمستعمرات/السنتمتر المربع.

الملامح البارزه في سجل الكشف الحي بالمسلخ تفيد أن متوسط الحيوانات المدخلة للذبيح 417 راس ومتوسط الحيوانات المجازه للذبيح 402 راس، متوسط الحيوانات المستبعده 3 راس.

الأسباب الرئيسية للاستبعاد هي للعرج، القراد، تورم الغدد اليمفاوية، جدري الضأن والهزال. الفصائل الحيوانية السائدة التي أدخلت هي (الحمري- الكباشي وبطانه) وهي فصائل الضأن المحببة للمستهلكين.

سجل كشف الذبيح أفادنا بان متوسط الذبائح التي تم قبولها 402 ذبيحة. بينما متوسط الذبائح التي استبعدت كانت 4 ذبائح بسبب اليرقان، الأكياس المائية، التهابات الغدد الليمفاويه ، الخراج والبقع الدموية المنتشره. متوسط درجة حرارة صالة الذبيح 34°م والمستوي الصحي للصاله كان جيداً .

غرفة التبريد بالمسلخ كانت جيده من الناحية الصحية و لا توجد روائح . و متوسط درجة الحرارة - 0.9°C ومتوسط زمن التبريد 13 ساعة . أما الثلاجات الناقلة متوسط درجة حرارتها -1.4^0C متوسط الفترة الزمنية بالناقل المبرد 5 ساعات و متوسط حرارة الذبيحة 0.02°C ، الحالة الصحية للثلاجات الناقلة كانت جيده حيث لم يحدث انفصال للسائل ولم تشتم روائح غير مقبولة باللحوم المعدة للتصدير .

INTRODUCTION

Sudan is the most spacious country in Africa and in the Arab world. It is the first in animal resources. Nile and its tributaries extend through Sudan from South to North through extended areas of high rainfall, arid and semi arid regions. Among these regions and adjacent to them lie vast pastoral areas.

Animal resources in the Sudan comprise sheep, goat, cattle, camel, poultry and wild-game. Most of the animals in the Sudan are raised on natural pastures by nomadic tribes. In irrigated projects and the area of mechanized farming animals feed on crops byproducts. So Sudanese animals are almost free from feed additives, hormonal and chemical residues. A fact which gives special preference to the Sudanese animal products. Live sheep and mutton represent an important component of the Sudanese exports.

Table (1) : Estimation of sheep population , exported live sheep and exported mutton .

Year	Sheep population head	Exported live sheep	Exported mutton (ton)
2000	46095000	731242	6157.8
2001	47043000	15417	4855.2
2002	48136000	1602638	7113.8
2003	48440000	1315399	7837.11
2004	48910000	1703562	5570.9

Source: Animal Resources Economics Administration Ministry of Animal Resources and Fisheries, Information and Statistics Unit (2005).

Establishing a hygienic program for exported mutton is of utmost importance in order to enable the Sudan to cope with the international trade parameters. This entails a vital need to improve the slaughter houses and to impose strict hygienic measures to provide healthy and wholesome meat to fulfill the international requirements.

Being a meat hygienist for around ten years has a roused my personal concern to contribute to the improvement of the standards of hygiene of the exported mutton.

The present dissertation is an account evaluation of the efforts undertaken by the concerned meat hygiene authorities to produce high quality meat for export.

CHAPTER ONE

REVIEW OF LITERATUER

1.1 Meat

1.1.1 Definition

Meat is the edible parts of the food animals e.g. Sheep, goat, horse, deer .etc. which consume grass and other arable crops (Gracey *et al*., 1999).

Devie (1970) defined meat as the carcase of an animal used as food, including domestic mammals raised for food. It is composed of lean muscles, connective tissues, fats, water, bones, nerves and blood vessels. The main types of known meats in the Sudan are veal, beef, lamb and mutton.

1.1.2 Structure and chemical composition:

Carcase meat consists of lean, fat and bone, together with connective tissue; the fat can be subcutaneous (lying under the skin of the animal), intermuscular (lying between individual muscles) or intramuscular (occurring with in the muscle). Subcutaneous fat is relatively easy to trim to produce leaner-looking meat; intramuscular fat is more difficult to remove. Intermuscular fat is also referred to as marbling fat because when abundant it gives a marble appearance (Warriss, 2000).

Considering its complexity, the animal's body consists of 50-60% water relatively few kinds of chemical substances 3-4%. The remaining 35-40% consists of organic substances. These are complex compounds of carbon (C), hydrogen (H) and oxygen (O), sometimes together with nitrogen (N), sulphur (S) or other elements which are in general found in living organisms. Three

major categories of organic compounds are important in nutrition proteins, fats and carbohydrates. The approximate composition of the meat in terms of these components was given in table (2). The muscle tissue consists of about 75°C water and 20% protein. A large part of the remaining 5% is fat with very small amounts of carbohydrates (principally glycogen), free amino acids, dipeptides and nucleotides (Warriss, 2000).

Table(2) The approximate composition of meat animal

Substance	**Percentage**
Inorganic	
Water	60%
Mineral	4%
Organic	
Protein	20%
Fat, (lipids)	15%
carbohydrate	1%

Table (3) The percentage of tissues in the carcases of food animals

Types of tissue	Percentages
Muscular tissue	60-65%
Connective tissue	10-16%
Fatty tissue	5-30%
Bony tissue	7-32%

1.2 Selected recent relevant local and international studies

An evaluation of sanitation and its impact on meat preparation was made in Elkadaro slaughter-house by Suliman (2004). The author examined 80 samples randomly from the slaughter-hall (wall, air, floor, knives of slaughtering, skinning, evisceration and inspection, worker hands, skinning and evisceration sites, water and carcase), at the end of all meat preparations. Her results revealed a total aerobic plate count (TAPc) of 2×10^4 CFU/cm^2 for wall, 1×10^4-9×10^4 CFU/cm^2 for floor, 6×10^5 CFU/cm^2 for knives and 3×10^4 CFU/cm^2 for carcase. While the count of water samples was 2 CFU/100 ml. She was able to isolate Staphylococcus, *Micrococcus, Aerococcus, Bacillus, Corynbacterium, Hoteria, Kurithia, Enterococcus, Eubacterium, Actinomycetes, Actinobacillus, Enterobacteria, Aeinetobacter* and *Chromobacterium.*

Another research for assessment of meat hygiene practice in slaughter-house in Khartoum State was made by Fadlalla (2004). He under took bacteriological

examination from working tools, hands of the worker and various parts of the carcases. The bacterial isolates were *Staphylococcus Spp., Bacillus cerus, Micrococcus Spp., and E.coli*. he recorded that highest count appear in the middle of the work on skinning knives as well as the outer surface of the carcase trunk while the lowest count were obtained in the beginning of the work.

Elamin (2002) made bacteriological investigations on the surface of mutton carcases from Elsabaloga Slaughter-house and Omdurman retail meat market. She found unacceptable levels of contamination which ranged from less than 1×10^8 and more than 3×10^8 CFU/cm^2 of the surface. The author found that the main bacterial isolates were *Staphyllococcus, Micrococcus, Kurthia, Corynebacterium, Enterobacteria* and *Pseudomonas* species.

Study was done by Bakhit (2004) to evaluate the quality of meat (exported beef and mutton) out of 32 samples of beef (78.1%) showed uncountable number of colonies and (out of 30 samples) (50%) of mutton showed uncountable number of colonies. The author explained that quantitive bacteriological analysis of samples showed unacceptable level due to lack of application of hazard analysis critical control points (HACCP) system.

Smith and Graham (1978) studied the destruction of *Escherichia coli* and *Salmonella* on mutton carcases by treatment with hot water. The study showed that the surface tissue of beef and mutton samples were not permanently discolored to an objectionable extent by treatment with water at 80°C for 10 seconds. This treatment destroyed more than 99% of the numbers of *E. coli* and

Salmonella inoculated on the beef samples and more than 99.9% of the same organism inoculated on the exterior surface of tissue taken from sheep carcases.

Purvis *et al* (2005) studied the persistence of *Salmonella typhimurium DT 120* in abattoir paddocks holding sheep. This study was made during an era of outbreak of *Salmonella typhimurium DT.120* in people in North England. This srtain is resistant to antimicrobial agent; the out break was linked whith mutton and lamb from a local abattoir. Isolation of *Salmonella typhimurium DT-120* has taken place from faeces and soil samples taken from paddock in the abattoir lodging sheep before slaughter.

Pepin *et al*. (1997) studied public health hazard from small ruminant meat products in Europe. They revealed that there were pathogens associated with the consumption of mutton, in Europe. They listed *Clostridium perfringnes*, *C. parvun*, and *Campylobacter jejuni* as well as *E. coli* which is considered as emerging pathogen; classical zoonotic disease such as brucellosis toxoplasmosis, Q-fever and hydatidosis were also present.

Rivas *et al.* (2004) studied the isolation and characterization of *Archobacter butzleri* from lamb meat; the results showed that a number of isolates with indistinguishable field gel electrophoresis (PFGE) fingerprints were found to be epidemiologically related, which may indicate cross contamination of common types of *Archobacter* lamb meat.

1.3 Meat surface contamination and bacterial isolates

10^5 CFU/cm2 is considered satisfactory for fresh meat while 10^6 CFU/cm2 is considered unsatisfactory. For chilled meat 10^6 CFU/cm2 is considered satisfactory, while 10^7 is considered unsatisfactory. (Gracey *et al.*, 1999)

Banwater (1981) reported that normal sheep have microflora that was established in their early life. Besides this microflora, they tend to harbour different types of organisms found in their environment. Since they were contaminated by soil, air and feed excreta.

Dressed sheep carcases were sterile. Nevertheless, before were contaminated by bacterial deposit in their hides, personnel and the environment (ICMSF, 1980).

Number and distribution of microorganisms on the surface of fresh meat vary with the method of dressing and cleanliness of the environment (ICMSF, 1999). Frazier and Westhoff (1999) reported that important contamination, however, come from external sources during bleeding, handling and processing. In the post-mortem contamination bacteria usually originate from exogenous sources. Large numbers of bacteria of many kinds were naturally found on the skin, hoofs and cavities.

Bacteria found in the surfaces of the carcase after slaughter, were identical with those found in the animal hide. During the slaughtering process and handling, the environment become grossly contaminated (Thornton, 1952).

During dressing and evisceration the outer surface was mainly contaminated from the hide or skin, tools, equipments, water… etc.

Source of superficial contamination of carcase qualitative estimated by Serafoni (1967) as follows:

1. Direct on the skin of animals approximately 33%.
2. Pollution in abattoir atmosphere approximately 5%.
3. The visceral content in normal condition approximately 3%.
4. Transport and storage approximately 50% or more.
5. Halving, quartering and packing of carcases approximately 2%.
6. Miscellaneous, utensils, personnel … etc. approximately 3%.

Thornton (1968) investigated 40% of the carcase contamination occurred in the slaughter floor. Empey and Scott (1939) observed that transfer of microorganisms from the hide to the underlying tissue begin with the first stage of skinning. Bacterial counts were ranging between 10^4 to 10^5 viable cells per square centimeter of the superficial tissue of the carcase. Cross contamination may be acquired through water used in the slaughter process. Washing of carcase immediately after slaughter is the standard of industrial practice, however, washed carcases usually were not sanitized (ICMSF, 1980). A considerable reduction in the bacterial count associated with the use of chlorinated water (Patternson, 1972).

Ayres (1955) reported that bacterial contamination in water collected from the utensils used for washing of slaughtering tools. If water was reused continuously the microbial content increases rapidly.

Dirty hands, clothes of workers and equipments can serve as intermediate sources of contamination found on meat (Frazeir and Westhoff, 1955).

Frazeir and Westhoff (1955) said that handling of the meat induces contamination from carts, boxes and other container. They isolated many kinds of meat contaminants include human pathogen, especially intestinal type.

A source of bacteria in the carcase is the lymph nodes, which filter out bacteria from the lymph. Microbial count of 10^5/gm from the lymph nodes were found (Banwart, 1981).

Accidental puncture of the intestine or the stomach was found to be a source of contamination, besides the equipments used in slaughtering and dressing tools. Knives, saws, cleavers, hooks, wiping cloth and brushes made significant contribution to the over all contamination.

Bacterial counts were ranging between 10^4 to 10^5 per square centimeter of the superficial tissues of the carcases. Gross contamination may be due to water used during the slaughtering process. Washing of carcase immediately after slaughter is standard industry practice (ICMSE, 1980).

The most frequent coliform bacteria present in meat were *Escherichia coli*, *Klebsiella* spp., *Citrobacter* spp., *Enterobacter cloacae* and *Arizona* spp. (Fatima, 1985).

Thornton (1952) found that the types of bacteria in the slaughterhouse were *Staphylococcus*, *Micrococcus*, *Bacillus*, *Pseudomonas*, *Achramobacterium*, *Aerobacter* and Coliforms.

In processed meat subjected to qualitative analysis in the Sudan the following results were obtained. The percentage of pathogenic bacteria sush as *Salmonella* spp. is 8.6%, *Clostridium perfringes* 4.6%, *Staphylococcus aureus* 30.4% and *Escherichia coli* 16.2%.

Hussein (1987) reported that the aerobic organisms isolated from fresh meat were *Bacillus* spp., *Staphylococcus* spp., *Diphtheroides* spp., *Micrococcus* spp., *Streptococcus* spp. and *Lactobacillus* spp.; while gram-negative isolates were dominated by *Escherichia coli*, *Citrobacter freundii*, *Proteus morgani*, *Alcaligene* spp., *Aeromonus* spp. and *Pseudomonus* spp.

John and Anthony (1974) stated that *lactobacteriaceae* may be the eventual cause of meat spoilages, under some condition in meat handling, where it enters the product through contamination from plant equipment or workers handlers of the product. Lawarie (1991) found that the organisms derived from infected personnel or healthy carriers include *Salmonella* spp., *Shigella* spp., *Eschirchia coli*, *Bacillus*, *Proteus*, *Staphylococcus albus* and *Staphylococcus aurues*. *Clostridium welchii*, *Bacillus cerues* and faecal streptococci; According to Gracy (1999), describing a study in North Ireland that showed a wide range

of organisms isolated from all areas of the abattoir. Isolated organisms were mainly gram-positive *Bacillus*, *Coryneform*, *M. thermospactum*, *Enterobacteriaceae*, *Aeromonus*, *Vibrio*, *Citrobacter*, *Enterobacter*, *Hafnia*, *Serratia*, *Klebsiella* like organisms, *Yersinia enterocolitica* like bacteria and *Salmonella dublin*.

Bacteriological contamination in waste water from slaughter houses, revealed that the total viable bacteria at 37°C and 22°C ranges between 10^6—10^8/ml. coliform and *E. coli* in the sample of the some slaughter houses varied widely. Slaughtering of pig increases contamination of wastewater with *Salmonella* compared with that of slaughtering cattle. The cleaning and scraping of the gut increases considerably the number of *E. coli*, coliform and *Salmonella*.

Samples examined were contaminated with staphylococci of which the maximum number was 1.5×10^4/ml. Strain coming from pig slaughterhouse belong to the species of *Staph. aureus* and *Staph. hyicus* sub. *hyicus* and those of slaughterhouses of cattle only belong to species *Staph. hyicus* sub. *hyicus* (Dezutter, 1980).

Among the bacterial genera present in air and dust *Bacillus* and *Micrococcus* species which were able to tolerate dryness to varying degree (Jay, 1984).

The microbial status of the product that reached the consumer either raw or processed will depend on the exposure to contamination and it is control during subsequent chilling, processing, handling, distribution and preparation (Sofos *et al*., 1999).

According to Ajit *et al*. (1990), studied twelve *Salmonella* isolates from lymph nodes of slaughter sheep. The isolate from muscle included *Escherichia coli*, *Proteus*, *Pseudomonus*, *Klebsiella*, and *Citrobacter*. Also the study reported that contamination after slaughter was probable in many cases.

Fatima, (1990) founded the aerobic plate count (APC) of meat before processing in Khartoum was 10^3 CFU / gram.

Intisar,(1998) recognized different types of aerobic bacteria present in Omdurman slaughter house and Khartoum north retail markets; the bacterial isolates were Gram positive genera especillay *Micrococci* and *Enterobacteria*.

Salih, (1971) reported heavy contamination of fresh meat in Khartoum state with spoilage bacteria of genera *Micrococci*, *Streptococci* , *Bacill* , *Pseudomona* and *Aerogenes* .

1.4 Meat hygiene practice

The safeguarding of countries meat supply depends on diligent implementation of legislation related to abattoir construction and operations with regard to the following (Gracey, 1986)

1. The wise use of chemical and pharmaceutical preparation in the farm
2. Promotion of high health standards in live-stock and their general care during transportation, at auction markets and in the meat plant lairage.
3. Anti-mortem examination to eliminate unfit animals and to make provision for special post-mortem examination
4. Post-mortem examination of the carcase and offal immediately after slaughter, including laboratory testing where necessary
5. Removal of unfit material for human consumption and it is efficient destruction at processing plant located outside the meat plant.
6. Maintenance of standards of hygiene at all stages from the farm to meat plant, meat processing factory, cold storage, restaurants kitchens, and the consumer's home. A good meat hygiene system not only results in the provision of sound and wholesome product for human consumption with good keeping qualities but can also make an important contribution to the control of animal diseases by

making available to producers the valuable information obtained from meat inspection findings.

1.5 International standards for abattoir construction and operation

1.5.1 Definition

Abattoirs are premises that approved and registered by the concerned authorities where animals are slaughtered and dressed for human consumption. (FAO/WHO,1993)

1.5.2 Site

FAO, (1978) recommended that the site should be chosen at a higher level from the surroundings. This will make easier drainage and will prevent pools of stagnant water formation around the slaughter house. Proper drainage should be cared for to avoid pollution. Direction of the prevailing wind must be considered. Religious believes must be cared for.

1.5.3. Construction

according to FAO (1991), meat export establishment should comply with the following requirements:

a. Proper construction is a pre-equisite for effective operations and it ensures safe and acceptable satisfactory surroundings to minimize dust and accumulation of debris, and run-off water and waste.

b. Adequate insect and vermin protection.

c. Sufficient ventilation, cleaning processing and handling equipments

d. Sufficient refrigerated storage for the final product.

e. Abattoirs should include amenities for employees. Each abattoir should include suitable working areas.

f. Foundation and floors must be made of concrete. Drain must be impervious to water. The finished floor must be easy to clean, and not slippery and should be sloped towards drains

g. Physical barriers must be made between compartments of edible and inedible materials.

h. Physical separation must be made between areas of clean and dirty operations.

1.6 Animal Welfare

1.6.1. Prior slaughtering rest

Meat hygiene and inspection legislation of Khartoum State (1999) recommend that animals should have enough rest. Diseased animals or animal at late pregnancy are not accepted for slaughter. Prior slaughter rest of the animals is needed to optimize physiological functions and to help in detecting evidence of any disease which my be recognize during this period (FAO/WHO 1993).

1.6.2. Feeding

Meat hygiene and inspection legislation of Khartoum State (1999) imposes quarantine ranged between 12 hours to 72 hours for animals, before slaughtering, within this time the animal is supplied with drinking water. Ample drinking water provision for animals retained in the lairage before slaughter will lower the bacterial load in the intestines and facilitate easy removal of the hide during carcase dressing.

Fasted animal bleed better and the carcase will have brighter appearance, (Gracy *et al*, 1999).

1.6.3. General health condition

Defective or diseased animals must be separated from healthy ones, to receive special care and prevent cross contamination (FAO/WHO 1993). Varnam and Sutherland, (1995), reported that preslaughter handling of animals has a profound impact on meat quality. Stress lead to increased defecation and animal body contamination and increased risk of meat contamination. Dirty animals must be cleaned before entering slaughter hall to prevent

contamination of meat. FAO/WHO, (1993) imposed that reasonably dirty animal should be cleaned to the extent necessary to minimize the risk of meat contamination and slaughter-house and dressing areas, before it is allowed to enter the killing flour.

1.6.4. Meat animal transportation

FAO/WHO, (1993) recommend that: food animal must be transported in such a way to avoid contamination, stress, spread of pathogenes. Identification of place of production must be recognized and animal welfare must be considered. Vehicles used in animal transportation to the abattoir should be maintained in a good repair condition and must be cleaned and disinfected after animals have been unloaded.

1.6.5. Slaughtering method

Good hygiene practice and manufacturing practices will minimize the substantial seen or unseen contamination, during slaughtering and dressing. Training programs are important in achieving hygienic slaughtering and dressing. Adequate supervision to ensure compliance with international requirement must be maintained (FAO/WHO, 1993). Islamic method of slaughter forbids stunning of animals prior to slaughter, (Sariy Eldin, 1972). The method of slaughtering is ritual. Holy Quraan recommends the cutting of the blood vessels for draining of blood. The act of slaughtering (Al-Dabh) is allowed in the name of God; therefore uttering the name of Allah is always practiced. (Gracey *et al.*, 1999).

1.7 Inspection

1.7.1. Ante-mortem inspection

A universally adopted requirement is that prior to slaughter all animals must receive ante-mortem inspection to ensure that: animals showing disease symptoms or conditions that render their meat unfit for human consumption are not used for human food. Only healthy ones are therefore slaughtered (FAO, 1991). Animals inspection before slaughter, to help in identification of clinical signs of diseases which, make the meat unfit for human consumption. Warriss, (2000) reported in UK and many other countries, anthrax, foot and mouth disease, brucellosis, rabies and tuberculosis during ante-mortem. Animals with disease which affect, the suitability of meat for human consumption, should be isolated, from other animals. (FAO/WHO, 1993).

The provision of veterinary inspection of live animals prior to slaughter is of utmost importance for most of the meat inspection systems, (Gracy *et al*, 1999). Ante-mortem inspection implies three main aspects. Public health aspect animal health and animal welfare. The veterinarian must separate animal suffering notifiable diseases.

The ante-mortem processes allow the Veterinarian to assess the welfare implication within the Lairage Gracey *et al,* (1999).

1.7.2. Post-mortem inspection

Ibrahim (1990) reported that meat inspection was practiced in France as early as 1162. The main objectives of meat hygiene and inspection were to avert meat spoilage and to prevent meat borne infections. The economical benefits from these objectives were not negligible

Varnam and Sutherland (1995) reported that meat inspection to ensues the fitness of meat set for sale, involved visual examination. Animals suffering disease such as tuberculosis or parasitic infestation, inspection take place immediately after slaughter in the early stage of dressing. According to the previous authors meat inspection is a means of quality control and a tool for meat grading and is considered essential for export data.

FAO, (1991) required that inspection must include head, carcase and viscera and must be performed by qualified inspectors under conditions which enable them to detect defective material, by providing adequate light together with especially designed inspection areas equipped with examination tables and other essential equipments for satisfactory inspection.

Management of each abattoir must have access to laboratory services. Analytical procedure, used should follow standard methods in order that the results may be readily interpreted (FAO/WHO, 1993).

1.8 Wrapping and packaging of meat

Packaging material and design should protect the product and minimize contamination (FAO/WHO, 2001).

According to Saudi Arabian Standards Organizations (1978) the following requirements should be considered in packaging

i. Packaging and wrapping materials shall be stored in sanitary manner to prevent contamination.
ii. The wrapping materials shouldn't leave any poisonous or harmful impact on the meat, or cause contamination with any undesirable substance
iii. The carcase and the cuts shall be warped with clean, light and porous clean cloth.
iv. Warping or packaging must provide full protection for meat cut from contamination during handling, transportation and storage.

1.9 Preservation and storage

Al Shrek (1996) recommended that meat preserved or chilled at about zero °C will ensure no pathogenic bacterial growth or, toxin production. Fast chilling at low temperature with high air speed and low humidity may reduce bacterial number. The carcase holding time in the chiller may have more effect on the microbial population than the chilling temperature (International Commission of Microbiological Specifications for Food (ICMSF), 1980).

Carcase must first be chilled at about seven °C for 16 hours then be stored at a near zero °C until shipping for export. The length of two weeks is the maximum safe period for preserving chill meat under good storage conditions. (Alshrech, 1996). Chilling coolers set at temp. ranging from four °C to zero , in major factories affecting, chilling rates include, specific heat of carcase, carcase size, amount of external fat and temperature of chilling environment. (Judge *et al.*, 1988).

Chilling is a critical control point in determining the microbial quality of meat. Chilling should be adequate. European community regulation impose a deep muscular temperature of seven °C within 24 hours of slaughter. (Varnam and Sucherland ,1995).

Chilled meat should be mechanically chilled to temperature ranging from 1.2°C to 3.5 °C immediately after slaughtering within a period not more than 24 hours (Saudi Arabian Standards Organization, 1978).

Chilled carcase and meat should be stored at temperature ranging from one to zero °C and should reach the consumer within four weeks from the slaughter date.

1.10 Transportation

The following restrictions must be cared for during transportation:

a. The means of transportation should be mechanically cooled in case of chilled meat.
b. The means of transportation should be clean and disinfected before loading.

c. Means of transportation of meat, must not be used for conveying live animals or any harmful material
d. All surfaces in contact with meat during transportation should be erosion resistant, smooth and easy to clean and disinfect. (Saudi Arabian Standards Organization, 1978).

FAO/WHO, (1993) reported that transportation is an area of particular risk of contamination of meat from various sources. Particular care should be taken during transportation to prevent the growth of microorganism that may be present.

Transportation vehicle must be designed, constructed and equipped in a manner to prevent meat contamination from external sources, or from the vehicle it self and to prevent or limit the microbial growth.

Martin (1978) recommended that vehicle used for transporting meat should be especially designed for this purpose they should be totally closed when meat is transported, the floor, should be durable, to prevent absorption of grease and blood.

1.11 Labels and certificates

Saudi Arabian Standards Organization, (1978) imposed that imported lot should be provided with a certificate from the Saudi Consulate, proving that slaughtering has been carried out in accordance with the Islamic rules, and health certificate indicate the date of slaughtering, type of animal and its average age. The certificate must indicate that the animal has been inspected twelve hours prior slaughter and immediately after slaughtering by a veterinary inspector, and that the carcase was sound and free from infectious diseases and fit for human consumption. The imported lot should be accompanied with a certificate of origin, indicating the country from which the meat is imported and acknowledged and ratified by the Saudi Consulate or their representative. In case of chilled meat the period from slaughtering until arrival to the kingdom should be not more than five days.

The grading stamp is placed on carcase and cuts in the packing plant. It guarantees that a given cut of meat fit the right standards for eating quality.

Saudi Arabian Standards Organization (1978) imposed that the carcase fit for human consumption should be branded with appropriate stamp by authorized person in the abattoir. The branding ink should be stable and harmless. A final inspection immediately prior to shipment or loading into shipping container units for shipment. Nowadays meat transportation from a country to another by either land sea or air, adopting mandatory techniques for carrying out a final inspection of the product for each mean of transportation (FAO,1991). Locking the approved product in a safe storage, using stamper-proofed seals, which are to be broken only by inspectors of the export quality control and inspection agency of the importing country, so we made effective securing measure for the product.

CHAPTER TWO

MATERIALS AND METHODS

2.1 The Study site

The study was carried out in Elkadaro export slaughter house in Khartoum State. This is the most important export slaughter house in the Sudan.

2.2 Collection of informative data

a. Data on number of animals entering, the slaughter house the number of animals rejected, and the reasons for rejection, the number of animals passed for slaughter, and animal breeds were taken from Ante-Morteum records of the slaughter house.
b. Temperature and hygienic condition and range of animal carcass weight were also recorded.
c. The chilled carcase temperature and duration of chilling were also recorded.

d. The same in data b and c as well as the hygienic condition of the refrigerated truck were taken while un loading the refrigerated vehicle in the airport.

2.3 Samples collection

Five visits were made to Elkadaro Export Slaughter House from May, 31 to July, 16 2005.

Fifteen swabs samples were taken in each visit. Five samples were taken from the fresh carcases and five samples from the chilled carcases. Finally five samples were taken after unloading the carcase from the refrigerated vehicle at the air port.

2.4 Sampling Method

Sampling was done according to systemic random sampling methods as described by (Thrusfield 1996).

A total of 75 swabs (15 swabs in each visit) were collected. Five carcasses were selected and identified by label fixation as such: A, B, C, D and E. A hand-made right angled metallic triangle with an area of 10 C^2m was used as a template and was disinfected by using 70% alcohol (ethanol). Swabs were taken from specified area to detect muscle surface contamination of the carcasses.

Sampling sites from which swabs were taken as follows

A. swabs were taken from the thigh muscles

B. swabs were taken from external abdominal muscles

C. swabs were taken from chest area

D. swabs were taken from the shoulder muscles

E. swabs were taken from the vertebral area

Swabs were placed in ice box (0C°) and were transferred as soon as possible to the Preventive Medicine Research Laboratory, Faculty of Veterinary Medicine University of Khartoum. Swabs were stored in deep freezer at

-20 °C before processing took place.

2.5 Bacterial count

All collected swabs were processed for bacterial counts. Pour plate method was used for bacterial colony count as described by Quinn, etal (2000). The swabs were taken from the deepfreezer, then emersed in test tubes containing10 ml sterile normal salime. Then ten fold dilutions were prepared from the normal salime (10^{-2}, 10^{-3}, 10^{4}, and 10^{-5}).

A total of 100 µ (0.1 ml) was taken from the final dilution and placed in sterile Petri-dishes. Then (15-20 ml) of sterile nutrient agar solution (N.A) were added to the peteri-dishes contents. Mixing of the solutions was done by shaking the Petri-dishes clock-wise, then anti-clock-wise, then cross-like.

Then the Petri-dishes contents were let to solidifie before being incubated at 37°C for 24-48 hours for colony count. The average value from each duplicated

Petri-dishes of the same dilution was taken. The colonies were calculated using the following formula:

$$\textbf{Colony count} = \frac{\textbf{average value} \times 10 \times \textbf{dilution factor}}{10} = \text{CFU/cm}^2$$

10 refer to the area of the triangle used.

C.F.U/cm^2 refer to colony forming unit per square centimeter

2.6 Nutrient agar preparation

The medium was prepared as described by Oxoid, (1981). Twenty five grams of powder were added to one litre of distilled water and brought to boil in order to dissolve the powder completely. It was then sterilized by autoclaving for 15 minutes at 121 °C at pressure of 15 pound per square inch pressure.

2.7 Normal saline

It was prepared by dissolving 8.5 grams sodium chloride in one litre distilled water.

.2.8 sterilization

All glasswares such as tubes, Petri-dishes and flasks were sterilized by oven (dry heat) at 160-180^{o}C for one hour. Culture media and normal saline were sterilized by autoclave at 121^{o}C under 10-15 pounds/square inch for 15-20 minutes (Cruickshank, 1975; Barrow and Felthman, 1993).

Metallic triangle and working benches were sterilized using 70% acid alcohol.

CHAPTER THREE

THE RESULTS

3.1 informative data

Table (4): Ate-mortem records

Information / Visit No.	Date	Number of animals entering	Animal Breeds	No. of accepted animals	No. of rejected animals	Cause of rejection
First visit	31/5/2005	217	Hamari, Kabbashi Watish	215	2	Lameness Emaciation
Second visit	11/6/2005	501	Watish , Hamari	458	3	Two rams for lameness. One ram for tick infestation

Third visit	21/6/2005	446	Butana, Watish	443	3	Swollen lymph nodes
Fourth visit	28/6/2005	416	Hamari, Kababsh	414	2	Tick infestation Lameness
Fifth visit	16/7/2005	505	Kabashi, Hamari	501	4	Two rams for lameness One ram for sheeppox one ram for tick infestation

Table (5): Post-mortem records

Information / Visit No.	Number of animal entering	Carcase average weight	Slaughter hall temp.	Hygiene condition	Number of accepted carcase	Number of rejected carcases	Cause of rejection
First visit	215	21 kg	37°C	Good	213	2	Jaundice Hydatidosis
Second visit	458	19kg	33°C	Reasonable	456	2	Contusions Lymph nodes infection
Third visit	443	18kg	32°C	Good	440	3	Abscessation Lymph nodes inflammation
Fourth visit	414	17kg	34°C	Good	408	6	Two rams, hydatidosis Four rams inflammation of the lymph nodes
Fifth visit	501	20kg	36°C	Good	448	3	Two hydatidosis One inflammation of the lymph nodes

Table (6): Cold storage and cold transportation records

Information / Visit	Chiller			Refrigerated vehicle			
Visit No.	Temp.	Duration of chilling (Hrs.)	Hygiene standard	Temp. of vehicle	Aver carcase temp.	Time in the vehicle	Hygiene condition
First visit	-2°C	11	good	-2°C	0.8°C	4 hours	good
Second visit	- 0.3	15	good	two vehicles -0.7 -5 °C	-2 °C	4 hours	good
Third visit	0.5°C	13	good	two vehicles -2 0	0 °C	2 hours	good
Fourth visit	0.5°C	14	good	two vehicles -2 °C -0.2	-0 °C	10 hours	good
Fifth visit	-1.4 °C	12	good	two vehicles 2.5°C	1.4°C	6 hours	good

3.2 The surface contamination of mutton intended for export, from Elkadaro export slaughter house at three different stages:

The five visits revealed the following:

3.2. 1 First visit:

Counts of this visit revealed no contamination. In the slaughter hall relatively low counts recorded for the third and fifth carcase (9×10^3 and 1×10^3 CFU/cm^2 respectively). While the first, second and fourth shown the same counts which is 2×10^4 CFU/cm^2. In the chiller the first, second, third and fifth carcases shown the same reading which is 1×10^5 CFU/cm^2 , while relatively low count is recorded for carcase four (1×10^4 CFU/cm^2).

At the air-port similar counts were recorded for the first, second, third and fourth carcases (8×10^3, 1×10^3, $8\times10^3$and 7×10^3 respectively), while the fifth carcase shown relatively higher count (1×10^4 CFU/cm^2). Counts of the first visit were shown in Table (7).

3.2.2 Second visit

All the counts of this visit were below the contamination level. In the slaughter hall relatively high counts are recorded for the first, third and fourth carcases (2×10^5 for the first and 5×10^5 for the rest), while the second carcases showed no growth. In the chiller similar readings were recorded for the first, second, fourth and fifth carcases (4×10^5, $5\times10^{5,}$ 5×10^5 and 9×10^5), while the third carcase showed relatively higher reading (3×10^6 CFU/cm^2). At the air-port similar counts were read for the first, second, third, fourth and fifth carcase (8×10^5 , 1×10^5 , 3×10^5 , 3×10^6 and 8×10^5 respectively). Counts of the second visit were illustrated in Table (8).

3.2.3 Third visit

There was no contamination in the five carcases at the three different stages. Highest bacterial count at the slaughter-hall was observed in the second and third carcases (1×10^4 and 2×10^4 respectively). While the highest bacterial counts were revealed in the second; third and fourth carcases at the air-port (1×10^5 for the second and 2×10^5, CFU/cm^2 for the rest). A low bacterial count was observed in the fourth carcase (8×10^4 CFU/cm^2) at the chiller stage. The results of third visit were shown in Table (9).

3.2.4 Fourth visit

There was no significant contamination in the five carcases among the three different stages. For the slaughter-hall high bacterial counts were recorded for the first, second, and fifth carcase (2×10^4 for each). While the highest bacterial count at the chiller was obtained for the first and second carcase (1×10^4 and 9×10^4, respectively). At the air-port relatively higher bacterial counts were recorded for the first, third and the fifth carcase (3×10^4, 2×10^4 and 1×10^4 CFU/cm^2 respectively). The results of the fourth visit were given in Table (10).

3.2.5 Fifth visit

The results of bacterial counts of this visit revealed no contamination in the three different stages. In the slaughter-hall the highest counts were recorded for the first, third and the fourth carcase (2×10^6 for each). While similar higher bacterial counts at the chiller were recorded for the first (9×10^6), 1×10^6 for each of the fourth and fifth carcase. Similar higher bacterial count was recorded for carcase four in the slaughter-hall and the chiller (2×10^6, 1×10^6 respectively).

At the air-port the count for the same carcase was decreased to (5×10^4 CFU/cm^2). The results of the fifth visit were summarized in Table (11).

3.2.6 Critical point of contamination

For contamination the critical point is 10^7 CFU/cm^2 for chilled meat and 10^6 for fresh meat (Gracey *et al*., 1999).

Table (7): Bacterial count of the first visit

Carcase	Sample site	Bacterial count CFU/cm^2		
		Fresh caracase at slaughter-hall *temp.37°C*	Chilled carcase at the slaughter house *temp. 0.2°C*	Chilled meat at the air-port *temp. -2°C*
First	A	2×10^4	1×10^5	8×10^3
Second	B	2×10^4	1×10^5	1×10^3
Third	C	9×10^3	1×10^5	8×10^3
Fourth	D	2×10^4	1×10^4	7×10^3
Fifth	E	1×10^3	1×10^5	1×10^4

Duration of time in the chiller 11 hours

Duration of time in refrigerated vehicle 4 hours

Table (8): Bacterial count of the second visit

Carcase	Sample Site	Bacterial count CFU/cm^2		
		Fresh caracase at slaughter-hall *temp.33°C*	Chilled carcase at the slaughter house *temp. -0.3°C*	Chilled carcase at the air-port *temp. -2°C*
First	A	2×10^5	4×10^5	8×10^5
Second	B	No growth	5×10^5	1×10^5
Third	C	5×10^5	3×10^6	3×10^5
Fourth	D	5×10^5	5×10^5	4×10^5
Fifth	E	5×10^4	9×10^5	8×10^5

Duration of time in the chiller 14 hours

Duration of time in refrigerated vehicle 7 hours

Table (9): Bacterial counts of the third visit

Carcase	**Sample site**	**Bacterial count CFU/cm^2**		
		Fresh caracase at slaughter-hall *temp.32°C*	Chilled carcase at the slaughter house *temp. 0.5°C*	Chilled carcase at the air-port *temp. -2°C*
First	A	7×10^3	1×10^5	7×10^4
Second	B	1×10^4	1×10^5	1×10^5
Third	C	2×10^4	2×10^5	2×10^5
Fourth	D	3×10^3	8×10^4	2×10^5
Fifth	E	3×10^3	2×10^5	6×10^4

Duration of time in the chiller 13 hours

Duration of time in refrigerated vehicle 16 hours

Table (10): Bacterial count of the fourth visit

carcase	Sample Site	Bacterial count CFU/cm^2		
		Fresh caracase at slaughter-hall *temp.32°C*	Chilled carcase at the slaughter house *temp. 0.5°C*	Chilled carcase at the air-port *temp. -2°C*
First	A	2×10^4	1×10^4	3×10^4
Second	B	2×10^4	9×10^4	5×10^3
Third	C	5×10^3	3×10^3	2×10^4
Fourth	D	1×10^3	8×10^3	1×10^3
Fifth	E	2×10^4	8×10^3	1×10^4

Duration of time in the chiller 14 hours

Duration of time in refrigerated vehicle 14 hours

Table (11): Bacterial count of the fifth visit

Carcase	Sample	Bacterial count CFU/Cm^2

	site	Fresh caracase at slaughter-hall *temp.36°C*	Chilled carcase at the slaughter house *temp. -1.4°C*	Chilled meat at the air-port *temp. -2°C*
First	A	2×10^6	Temp. (-14°C) 9×10^6	5×10^4
Second	B	8×10^5	6×10^5	6×10^5
Third	C	2×10^6	8×10^5	8×10^4
Fourth	D	2×10^6	1×10^6	5×10^4
Fifth	E	6×10^5	1×10^6	1×10^5

Duration of time in the chiller is 12 hours for the (fourth & fifth carcase)

Duration of time in the chiller is 24 hours for the (first & second, third carcase)

Duration of time in refrigerated vehicle is 6 hours (for fourth, fifth carcase)

Duration of time in refrigerated vehicle is 3 hours (for first, second, third carcase)

CHAPTER FOUR

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

Sudanese mutton is famous for its high quality. This is attributed to its freedom from chemical and hormonal residues and it is low fat contents, as well as the distinguished Sudanese local breeds. For providing hygiene meat and meat products; maintaining high standard of hygiene in the abattoir is a matter of a paramount importance, this is maintained by continuous monitoring to establish a hygiene base and to ensure the quality of the products (Sofas, 1994). Applying the hygiene measures is reliable for achieving this goal, besides imposing the Hazard Analysis Critical Control Points system (HACCP) is a matter of great importance, by setting critical control points in trial to avoid these hazards, is a useful parameter for preventing contamination and other hygienic problems (Bakheit, 2004).

Exportation of live animals, animal products and by-products e.g. meat (beef, mutton…) and hides have a great contribution to the Sudanese national economy (Ministry of Foreign Trade, 2003) (Table 1).

Live animals and meat have a great economical significance and considered as a major economical source for Sudan before entering the petroleum era.

This study is a trial to highlight the situation in Elkadaro Export Slaughterhouse on basis of the ante-mortem record that revealed; the average number of the animal entering the slaughter house was 417 per visit. While average number of the accepted animals was 406 per visit, the average no. of the rejected animals was 3 animals. The major causes of rejection were lameness, tick infestation, swelling of the lymph nodes, sheep pox and emaciation.

Animal breeds entering the slaughter house were Hamari, Kabashi, Butana, which are known as Sudan desert sheep. In addition Watish breed were brought for slaughter. It is note- worthy that the majority of the breeds slaughtered for export were the most popular ones for mutton consumers whether at home or in the Gulf States and kingdom Saudia Arabia.

The post mortem record showed that, the average number of carcases entering was 402 the, average number of rejected animal was 4 the major causes of rejection were jaundice, hydatidosis, bruses, lymph nodes infection, abscessation and haematomas. The average temperature in the slaughter hall was 34°C. The hygiene condition is good in all visits. Slaughter house chiller revealed that, the average temperature was -0.9°C, while the average chilling time was 13 hour, the hygiene condition was good and no rancidity was noticed. The average temperature of the refergated vehicle was -1.4 the average holding time in the vehicle was 5 hours , where as the average carcase temperature was 0.02°C all the vehicle used were hygienic, since neither dripping nor abnormal odors were detected .

All the previously mentioned facts showed strict ante-mortem and post-mortem inspection mean while good hygiene was observed in the slaughtering process. The temperature of the chiller and the refrigerated vehicles were acceptable. The duration of chilling was satisfactory.

The results of the bacterial counts were below the critical contamination levels. Ample chilling time and good production practices have its significant impact on these results.

The surface bacterial load on the sheep carcase surface is essential in mutton grading, in order to cope with the international standards. Acceptability of meat must account for the following: abattoir hygiene, and the perfection of meat inspection in post mortem and ante-mortem. Anti-mortem must consider the animal condition, animal handling, and other aspects of the slaughter animal welfare. While post mortem must consider the Islamic slaughter, the perfection of bleeding, meat preservation, meat transportation and meat packaging. In Elkadaro slaughterhouse animals were rested for more than twelve hours before slaughtering, animal transportation is carried in a proper way so no stress take place, perfect bleeding is eminent and Islamic slaughter is strictly practiced total condemnation is nominal and mostly attributed to hydatidosis and icterus. While the main causes of rejection in the ante-mortem were lameness attributed to lymph nods infection or parasitic infestation or emaciation.

The major bacterial contaminants previously found on the carcase surface were *Corynebacterium, Lisleria , Staphylococcus spp., Micrococcus spp., Bacillus spp, Actinomycetes, Actinobacillus spp. , Chromobacterium* and *Enterobacteria spp*, (Suliman, 2004).

(Elamin, 2002) isloted Staphylococcal, Micrococcus, Corynebacteria, Kurthia, Entero-bacteria and Pseudomonia.

(Sary Eldin, 1972) reported the contamination of meat with staphylococcus coagulase positive.

(Hawarie, 1991) isolate *Bacillus* spp, *Salmonella*, *Shigella*, *Eschirichia coli*, *Proteus*, *Staphlococcus albus*, *Staph aureus* and faecal Strepococci,

(Gracy, *et al* 1999) consider 10^5 CFU/cm^2 satisfactory for fresh meat, while 10^6CFU/cm2 is the microbial count above which the sample is considered unsatisfactory. For chilled meat 10^6 CFU/cm^2 is the microbial count below which the sample is considered satisfactory, but 10^7 CFU/cm^2 is the microbial count above which the microbial count is considered unsatisfactory. Using these parameters most of the bacterial counts in the study were in the acceptable satisfactory level, so the study showed no contamination, and all the results for the chilled and fresh meat were found to be satisfactory.

ICMSF, (1980) reported that if meat is prepared under unhygienic conditions, the initial count is higher; exceeding 10^6 CFU/cm^2, the findings in this study disagreed with this facts. All the bacterial counts in the slaughter house were not exceeding 10^6 CFU/cm^2, these results, is indicative for good hygienic conditions.

The findings of this study revealed bacterial count disagreed with Elamin (2002) in slaughterhouse in Omdurman, where she found bacterial counts exceeding 10^7 CFU/cm^2 this disagreement is attributed to the following:

i. Elamin study was made in slaughter house in which the hygienic standards are far below that applied in Elkadaro slaughter house.

ii. In that slaughter house there is no demarkation between the area of clean and dirty operations.

Suliman (2003) found that carcase shoulder and thigh aerobic plate counts were 3.83×10^4 and 3.5×10^4 CFU/cm^2 respectively. That agreed with some of the findings in this study. As shown in

tables (7 and 11) The finding of this study agreed with (Frank and Mallion, 1980) who recognize that a recent slaughtered and dressed carcase will be contaminated with 10^2 -10^6 bacteria/cm^2. Most of the findings in the study are in agreement with (Gracy, 1980). Who pointed that after skinning 1×10^4-1×10^5 bacteria/cm2 were found in the tissues of the carcase.

Attaining high standards of hygiene, and providing high quality meat for export is a matter of a paramount importance, by so doing Sudanese meat and meat products can cope with the international standards of trade and so can compete in the international market. Strict hygienic measures must be followed in all the production stages.

Recommendations:

i. Proper sanitation must be done for the abattoir by using efficient sanitizing agents and decontaminants

ii. Regular sterilization of tools used in slaughtering, dressing and evisceration

iii. Provision of laboratory facilities to the abattoir, and regular investigation of the bacterial count in all stages of the production.

iv. Professional training program for meat inspectors and meat handlers.

v. Perfection of ante-mortem and post mortem inspection

vi. Proper handling and preservation of meat, by providing efficient cold storage facilities.

vii. Implementation of strict hygiene program HACCP by setting critical control points.

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APPENDICES

Appendix 1: Antemortem inspection

Appendix 2: Routine meat inspection

Appendix 3: Samples collection in slaughter house chiller

Appendix 4: Sheep Carcases in the refrigerated vehicle